

EFFECTS OF THE CONTAMINATION ENVIRONMENT  
ON SURFACES AND MATERIALS

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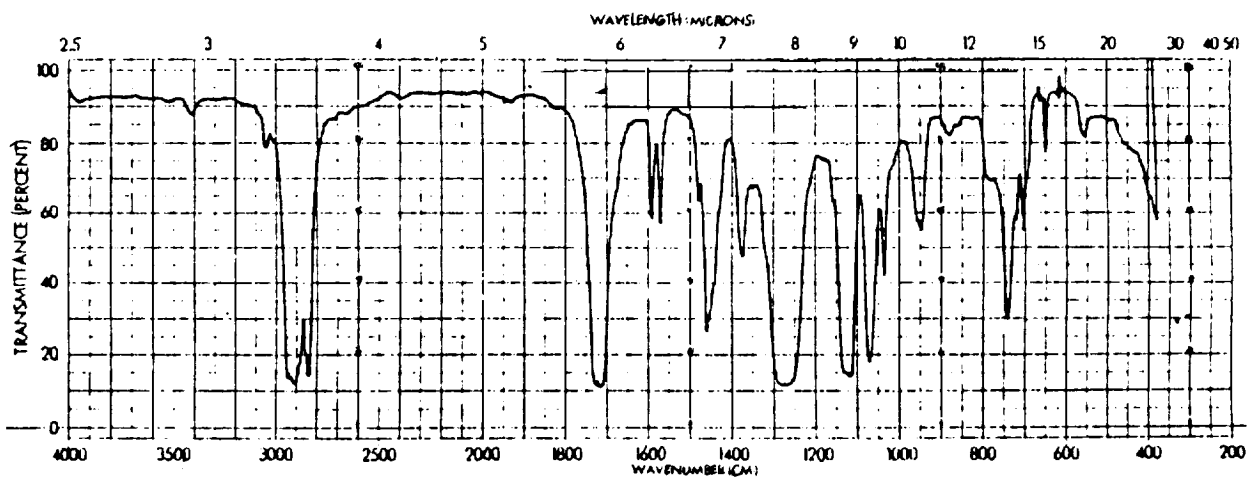
CONTAMINATION CAN BE CONSIDERED AN INDUCED ENVIRONMENTAL EFFECT. CONTAMINATION, BOTH MOLECULAR AND PARTICULATE, HAS CAUSED DEGRADATION IN BOTH OPTICAL AND THERMAL CONTROL SYSTEMS.

## INTRODUCTION

- o IN ADDITION TO THE ISSUES THAT HAVE ALWAYS EXISTED, NEW DEMANDS ARE BEING PLACED ON SPACE SYSTEMS FOR INCREASED CONTAMINATION PREVENTION/CONTROL
- o OPTICAL SURVEILLANCE SENSORS ARE REQUIRED TO DETECT LOW RADIANCE TARGETS. THIS INCREASES THE NEED FOR VERY LOW SCATTER SURFACES IN THE OPTICAL SYSTEM. PARTICULATE CONTAMINATION LEVELS TYPICALLY EXPERIENCED IN TODAY'S WORKING ENVIRONMENTS/HABITS WILL MOST LIKELY COMPROMISE THESE SENSORS
- o CONTAMINATION (MOLECULAR AND PARTICULATE) CAN ALSO AFFECT THE SURVIVABILITY OF SPACE SENSORS IN BOTH THE NATURAL AND HOSTILE SPACE ENVIRONMENTS

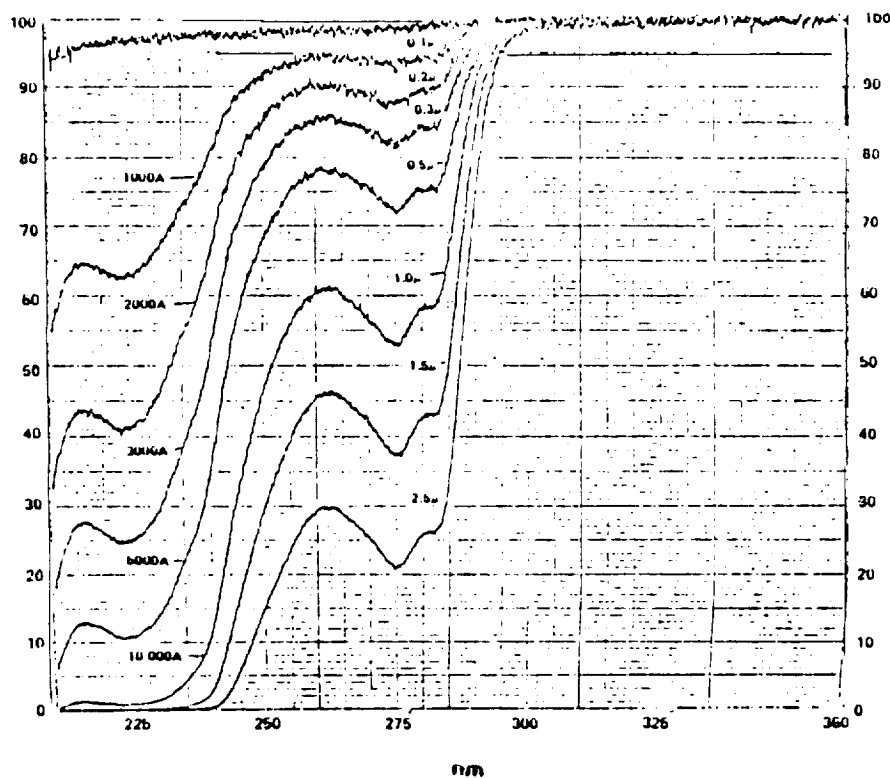
DI-OCTYL PHTHALATE (DOP) IS A TYPICAL SPACECRAFT CONTAMINANT. DOP IS USED AS BOTH A PLASTICIZER IN POLYMERIC MATERIALS AND AS A MATERIAL TO CHECK THE EFFICIENCY OF HEPA FILTERS IN CLEAN ROOMS. IT HAS BEEN OBSERVED TO BE CARRIED DOWNSTREAM IN THE AIR FLOW OF A CLEAN ROOM AND COAT CRITICAL OPTICS. AN IR SPECTRA OF A THIN FILM IS SHOWN BELOW.

## INFRARED ABSORPTION SPECTRA OF DI-N-OCTYL PHTHALATE



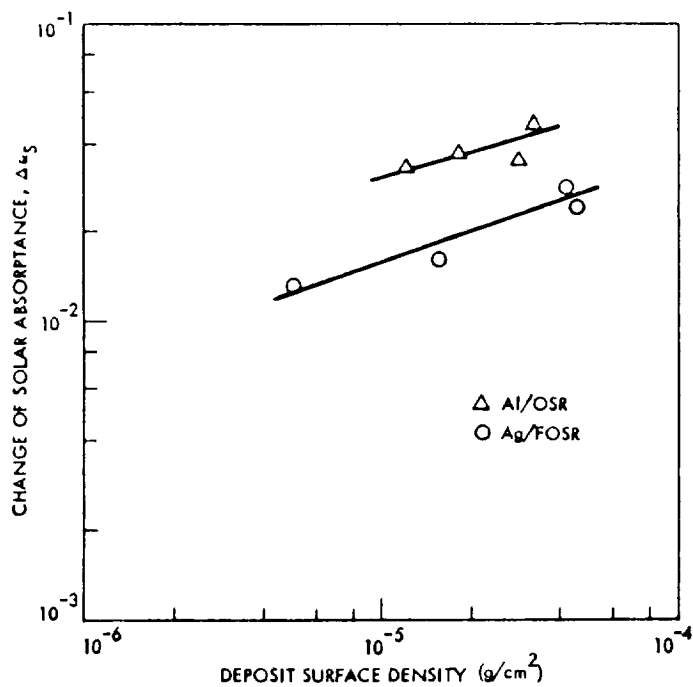
IN ADDITION TO HAVING STRONG ABSORPTION BANDS IN THE IR WAVELENGTH REGION, DOP ABSORBS STRONGLY IN THE ULTRAVIOLET WAVELENGTH REGION. ABSORPTION AS A FUNCTION OF THICKNESS IS SHOWN BELOW.

# ULTRAVIOLET ABSORPTION SPECTRA OF DI-N-OCTYL PHTHALATE



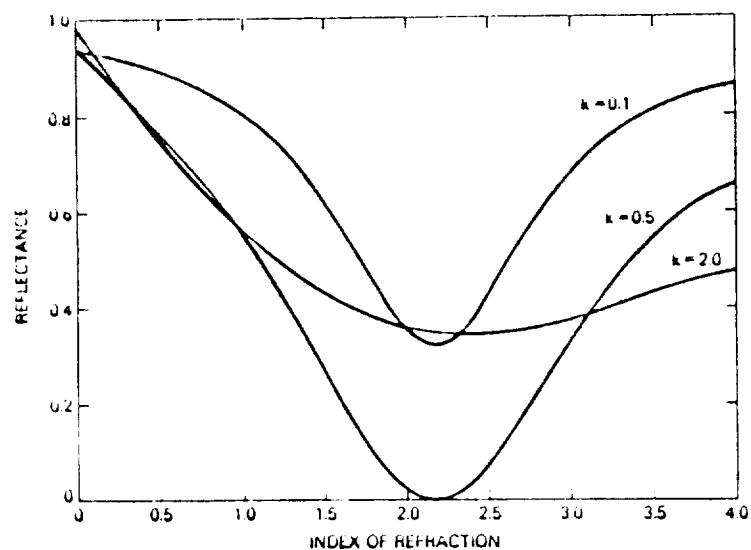
OUTGASSING PRODUCTS CAN ABSORB STRONGLY EVEN BEFORE PHOTOLYSIS CAN CAUSE ADDITIONAL DARKENING. THE FIGURE BELOW SHOWS THAT APPROXIMATELY 500Å OF RTV 560 OUTGAS PRODUCTS CAUSED A 0.03 INCREASE IN SOLAR ABSORPTANCE ON AN ALUMINIZED SECOND SURFACE MIRROR.

CHANGE OF SOLAR ABSORPTANCE BY RTV560 OUTGAS PRODUCTS



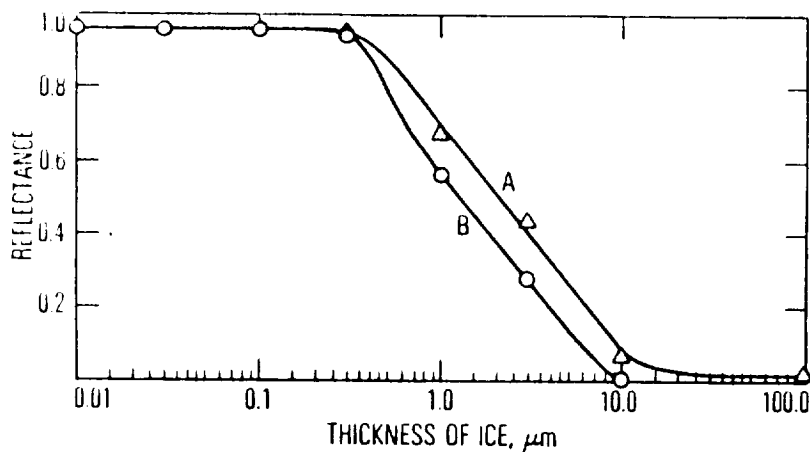
THE REFRACTIVE INDEX OF AN ORGANIC FILM CAN CAUSE GIGANTIC VARIATIONS IN REFLECTANCE IF DEPOSITED ON A MIRROR. BELOW ONE CAN SEE THE DIFFERENCES ON A FRONT SURFACE VIS/IR MIRROR.

REFLECTANCE AS A FUNCTION OF THE INDEX OF REFRACTION  
OF A CONTAMINANT FILM (550A) DEPOSITED ON A VIS/IR MIRROR



IN ADDITION TO ORGANIC FILMS, CRYODEPOSITS OF WATER ICE HAVE BEEN OBSERVED TO CAUSE SIGNIFICANT CHANGES IN OPTICAL PROPERTIES. THE CHART BELOW SHOWS EXAMPLES OF BOTH THEORETICAL AND EMPIRICAL DATA AS DEPOSITED ON A GOLD MIRROR.

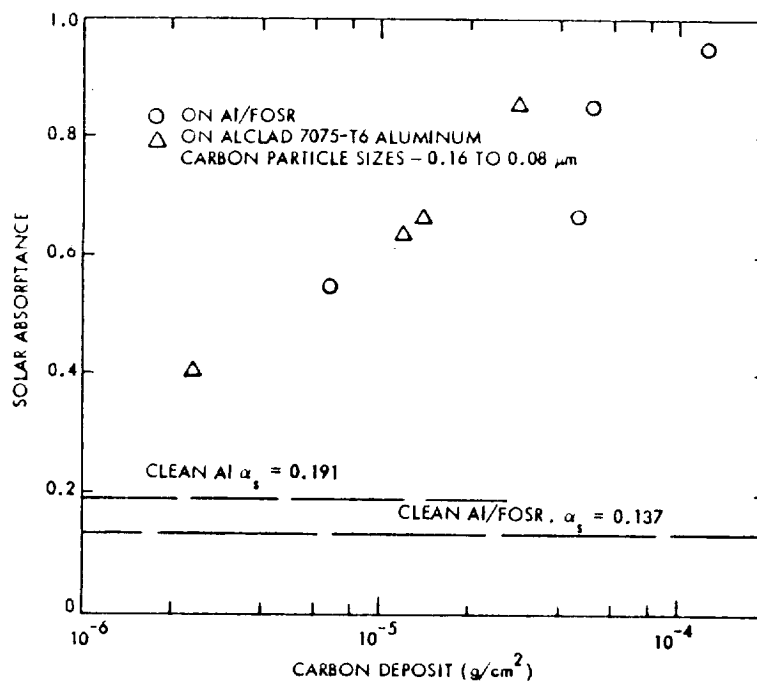
REFLECTANCE OF A GOLD MIRROR (MID IR) AS A FUNCTION OF  
WATER ICE THICKNESS



A = ESTIMATED AVERAGE  
B = WORST CASE

PARTICLES CAN CAUSE CHANGES IN THE RADIATIVE PROPERTIES OF THERMAL CONTROL SURFACES. AS CAN BE SEEN FROM THE FIGURE BELOW, CARBON PARTICLES ARE ONE OF THE MORE DELETERIOUS FORMS. CARBON PARTICLE DEPOSITS FROM SOLID ROCKET MOTORS (SRM'S) HAVE BEEN SEEN TO HAVE SIMILAR EFFECTS WHEN DEPOSITING ON THERMAL SURFACES.

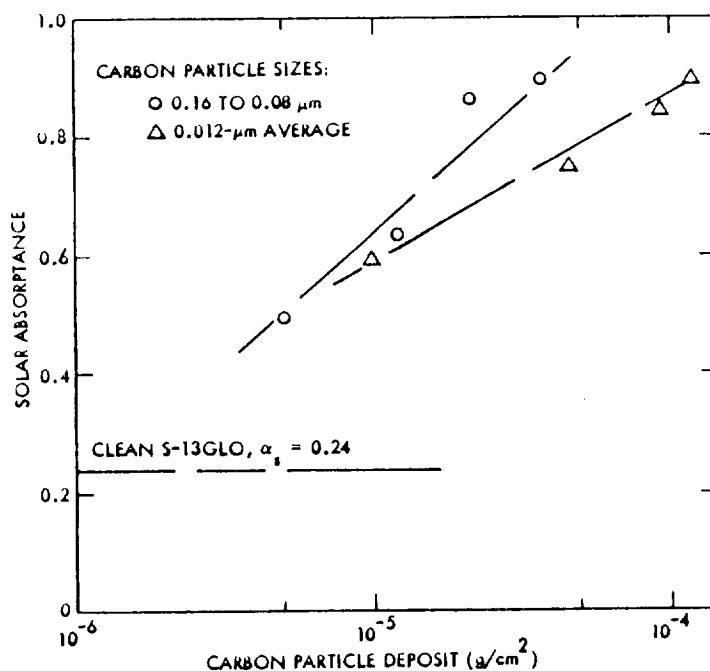
### CHANGE OF SOLAR ABSORPTANCE BY CARBON PARTICLE DEPOSIT





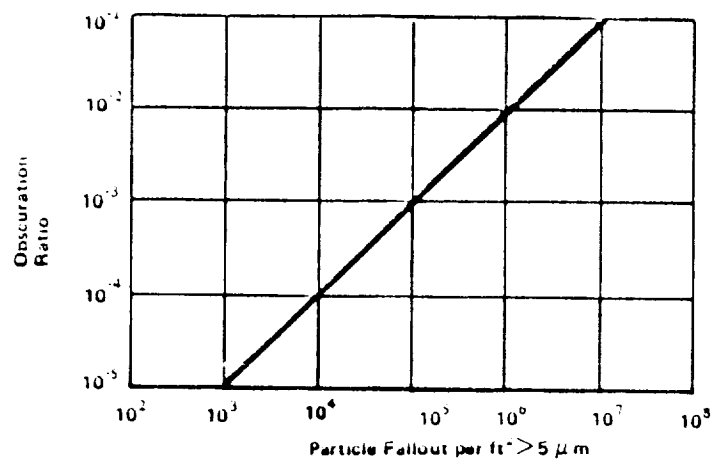
AS CAN BE SEEN, LARGER PARTICLE SIZES CAUSE GREATER CHANGES IN RADIATIVE PROPERTIES. THIS IS DUE PRINCIPALLY TO OBSCURATION. SMALLER PARTICLES, ALTHOUGH HAVING LESS IMPACT IN ANY CHANGE OF SOLAR ABSORPTANCE, CAUSE INCREASED SCATTERING.

# EFFECT OF PARTICLE SIZES ON CHANGE OF SOLAR ABSORPTANCE



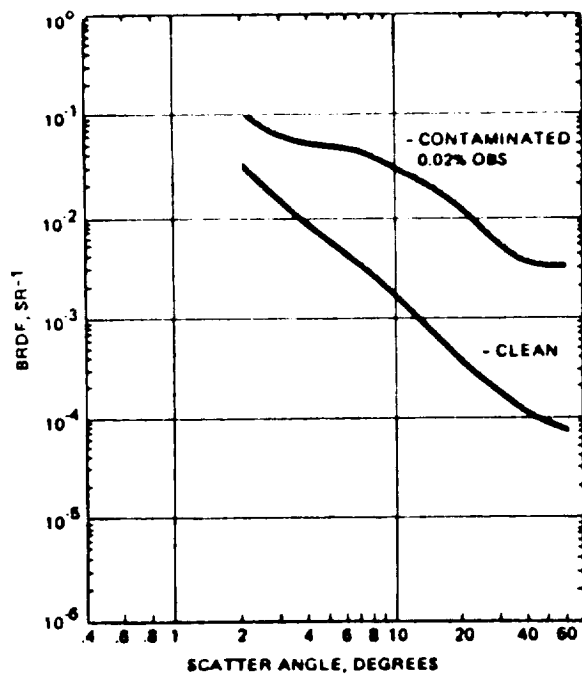
PARTICLES FIVE (5) MICROMETERS AND ABOVE CAN CAUSE SIGNIFICANT OBSCURATION AS EXHIBITED BELOW.

OBSCURATION RATIO OF A SURFACE VERSUS NUMBER OF  
PARTICLES PER FT<sup>2</sup> (>5 $\mu$ M)



THE BI-DIRECTIONAL REFLECTANCE DISTRIBUTION FUNCTION (BRDF), A METHOD OF DESCRIBING SCATTERING ON OPTICAL SURFACES, CAN BE SIGNIFICANTLY ALTERED BY SMALL PARTICLES.

### BRDF OF AN ALUMINUM MIRROR



IN ADDITION TO INDUCED CONTAMINATION FROM OUTGASSING PRODUCTS OR PARTICLE DEPOSITION, THE EFFLUENTS FROM PROPULSION SYSTEMS CAN BOTH DAMAGE SURFACES AND/OR CHANGE THEIR OPTICAL AND THERMAL PROPERTIES.

## PRODUCTION AND TRANSPORT OF PLUME EFFLUENTS

